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THE PRESERVATIVE TREATMENT OF FARM TIMBERS

[Revised, 1915]

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INTRODUCTION.

The amount of wood used on the farms of the country and exposed to decay is very great. The total is difficult to estimate, but it undoubtedly amounts to several billion feet. This wood is used in various forms, such as fence posts, building foundations, windmill frames, shingles, telephone poles, silos, etc. For such uses durability is usually the chief requisite.

Some woods resist decay more than others. A post of one kind of wood may last 10 years or more, while one of another kind may last only two years under the same conditions. There is also a great difference in the durability of wood of the same species under different conditions. In a very wet or a very dry situation a post will last longer than in a situation where the ground is simply damp. It will last better in a compact clayey soil than in a loose sandy soil. A warm, moist climate is more favorable to decay than a dry one, or one that has long, cold winters.

Naturally durable woods are continually growing scarcer and higher priced in most localities, and less durable woods must be used in their stead. Many of these woods in their natural condition

NOTE.—This bulletin is of value to all who are interested in prolonging the life of building timbers, poles, and posts, especially on farms at a distance from preservative works.

will last only two or three years in situations favorable to decay. It will readily be seen, therefore, that any reasonably cheap method of increasing their life will effect a material saving to the user.

For a number of years the Forest Service has been conducting experiments on the preservative treatment of fence posts, poles, and other forms of timber exposed to decay. These experiments have been made in cooperation with agricultural experiment stations, farmers, and various companies, and also upon the National Forests. They have proved conclusively that when a suitable preservative treatment is given the resistance of wood to decay can be very much increased.

DECAY.

Decay is not due to the chemical action of the soil or to the fermentation of the sap, but is the result of the action of certain low forms of plant life called fungi. These consist, for the most part, of very fine thread-like filaments, collectively called mycelium, which penetrate the wood in all directions. Certain substances in the wood constitute the food of the fungi. As these substances are dissolved the structure is broken down, until the wood reaches the condition commonly known as rotten.

The mycelium usually grows out to the surface to form compact masses called fruiting bodies. Since there are many kinds of fungi, there are many kinds of fruiting bodies. The various forms of "toadstools," "punks," "brackets," or "dog ears," which are so frequently found growing on trees and deadwood, are examples of these (see figs. 1 to 4). Their presence generally means that decay has made considerable progress in the wood. The function of all fruiting bodies is to produce spores, which are to the fungus what seeds are to higher plants. Millions of spores may be produced by a single fruiting body, and they are so small that they are able to float long distances in the air. When a spore drops into a crack in a piece of wood and conditions are favorable, it germinates and the fungus begins its destructive action.

Another way in which decay spreads is by the mycelium growing from one piece of wood to another. When a piece of decaying wood is in contact with a sound piece the latter may rapidly become infected in this way and be ruined.

The four requirements for the growth of fungi are moisture, air, a favorable temperature, and food.

A damp condition of the wood is probably the most favorable to decay. Wood can be either so wet or so dry that the fungi can not live in it. When submerged in water it has been known to last hundreds of years, and in perfectly dry situations it will often last indefinitely. Wood in contact with damp ground usually contains the right amount of moisture for the development of decay. Also, where timber is in contact with wood or other material, water fre-

quently collects in the joints and keeps the wood moist for long periods of time, thus favoring decay at these points. Familiar examples of this are decay in the tops of posts in board fences (see fig. 5), in the joints of various kinds of buildings (see fig. 6), in porch columns, in sills resting on wood or stone piers, and in lumber piles.

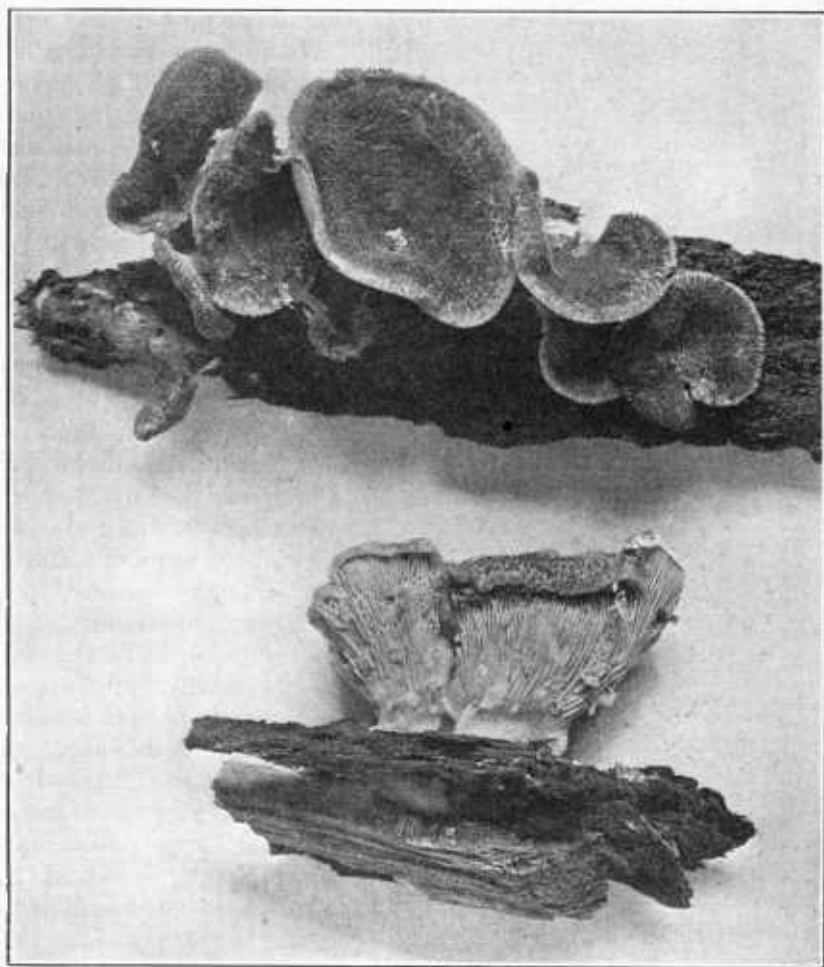


FIG. 1.—Fruiting body of fungus, *Lentinus lecontei*.

There are very few places where the fungus can not get air enough for its needs. When wood is buried deep in the ground, especially in compact or clayey soil, it tends to become saturated with moisture, so that decay is prevented; but within 2 or 3 feet of the surface of the ground there is usually enough air for the growth of the fungus. Conditions are most favorable, of course, just at the surface of the ground; and it will be noted that the point of greatest decay in a

fence post is usually near the ground line. Above the ground line moisture conditions are usually unfavorable, and below the ground line the air supply is less favorable for the development of decay. In loose or sandy soils, however, which under good drainage contain

more air than compact soils, decay may extend to the bottom of the post.

Wood-destroying fungi can not grow at very high or very low temperatures; but there are few, if any, climates in which the temperature during at least part of the year is not favorable to their growth.

The wood itself supplies the fourth requirement of the fungi, which is food. In order to prevent decay, it is necessary to deprive the fungus of one or more of these four requirements. It is out of the question in ordinary situations to deprive it of air and warmth; and though moisture can sometimes be eliminated to a certain extent, this can not be done when the wood is exposed to the weather. In general, therefore, the most effective method of preventing decay is to poison the food supply; and upon this principle is based the use of most successful wood preservatives.

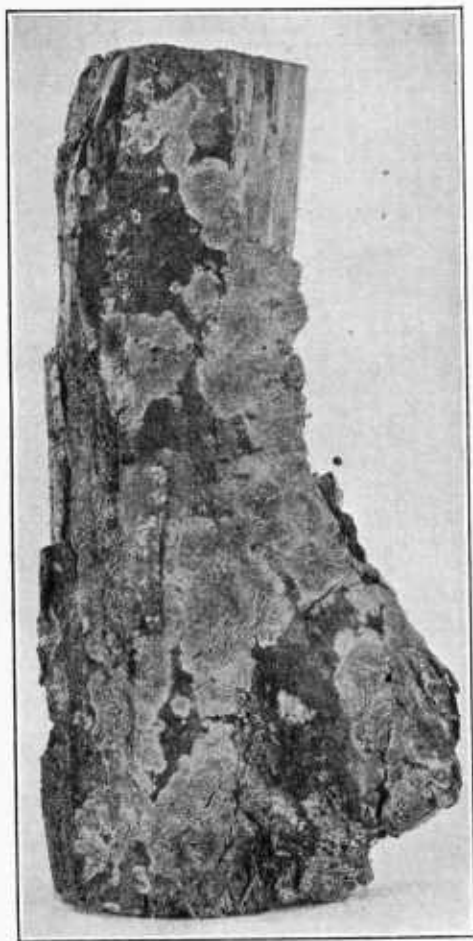


FIG. 2.—Fruiting body of fungus, *Poria* sp.

PROLONGING THE LIFE OF POSTS WITHOUT THE USE OF PRESERVATIVES.

PEELING.

Posts which are to be set without preservative treatment should always be peeled. The presence of loose bark allows moisture to collect, and thus makes conditions favorable to decay. It also harbors wood-boring insects, which, by boring tunnels, may both seri-

ously weaken the post and make conditions more favorable for rapid decay by affording easy access to fungi.

SEASONING.

The general impression has been that seasoning wood makes it more durable. In a number of experiments made by the Forest Service on poles and ties, however, green wood has been found as durable as seasoned wood. It is questionable, therefore, if it pays

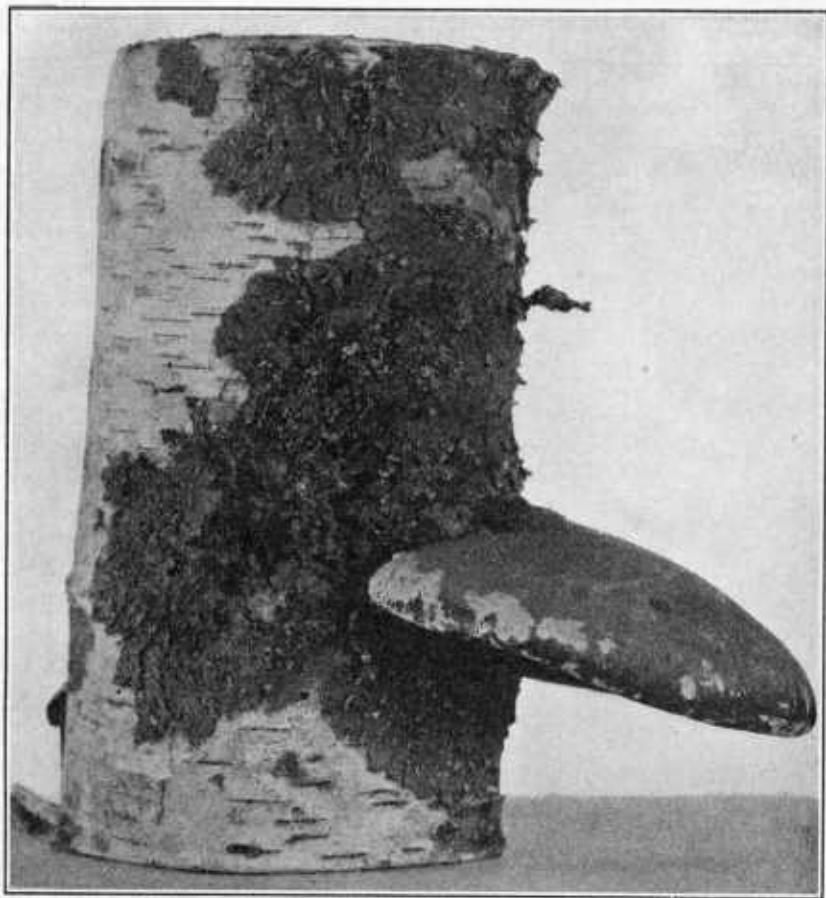


FIG. 3.—Fruiting body of fungus, *Polyporus betulinus*.

to season posts simply to increase their durability. If the posts are to be used in moist locations, the seasoned wood can quickly take up moisture and in a comparatively short time reach the condition of green wood. In any case, the seasoned posts will in time reach approximately the same condition as unseasoned posts under the same conditions.

In order to be of any value seasoning must be properly done, and the posts must not be held so long that decay begins before they are

set. The instructions for seasoning given on pages 11 to 12 should be followed. Posts should never be left close piled for any length of time.

CHARRING.

In some cases charring has appeared to give good results; in others, however, it has failed to give any appreciable protection, and it can not be relied upon.

STONES.

Piling stones around the base of the post has sometimes been resorted to. This tends to keep back the weeds and allow the air to

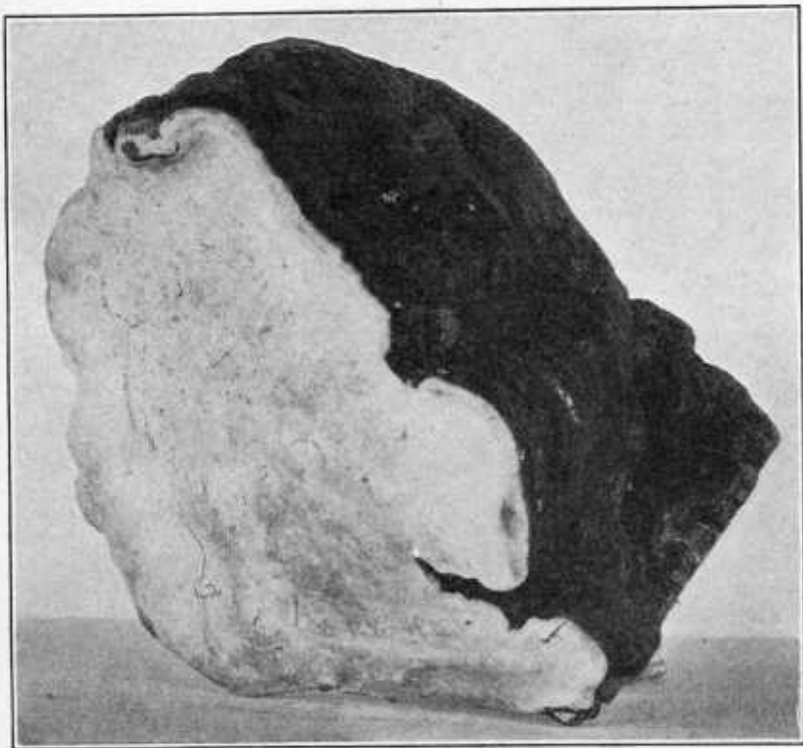


FIG. 4.—Fruiting body of fungus, *Fomes pinicola*.

circulate freely around the post. In some climates, however, where the ground is wet during a considerable portion of the year, the use of stones in this way has seemed to favor decay rather than retard it, because the post is allowed to dry out partially between wet spells. It would be better to keep it constantly wet.

In dry sandy regions posts are sometimes very badly cut by drifting sand being blown against the wood. This effect is sometimes called "burning." Piling stones around such posts would, no doubt, be effective in preventing the sand-cutting. It is doubtful, however, if results obtained by the use of stones for the sole purpose of preventing decay will justify the labor involved.

SETTING IN CONCRETE.

Setting posts in concrete may have a beneficial effect in some cases. If moisture should reach the post, however, it may be held there by the concrete and cause decay to proceed more rapidly. This is an expensive method of setting posts and can not be depended upon to prevent decay.

PROLONGING THE LIFE OF POSTS BY MEANS OF PRESERVATIVES.**REQUIREMENTS OF PRESERVATIVES.**

There are five chief requirements for a preservative for general use. It should be reasonably cheap, should penetrate wood readily, should not be corrosive to metal, should not evaporate or wash out of the wood easily, and should be poisonous to fungi. For special purposes there are, of course, additional requirements.



FIG. 5.—Decay in top of fence post and adjacent stringers due to collection of moisture.

VALUE OF VARIOUS PRESERVATIVES.**COAL-TAR CREOSOTE.**

Coal-tar creosote, which is a brownish-black heavy oil, practically insoluble in water, is in general use for preserving fence posts and other farm timbers. Satisfactory penetrations of many species of

wood can be secured with it, and excellent results have been obtained by its use. It is considered one of the most efficient preservatives against decay so far developed for farm timbers exposed to the

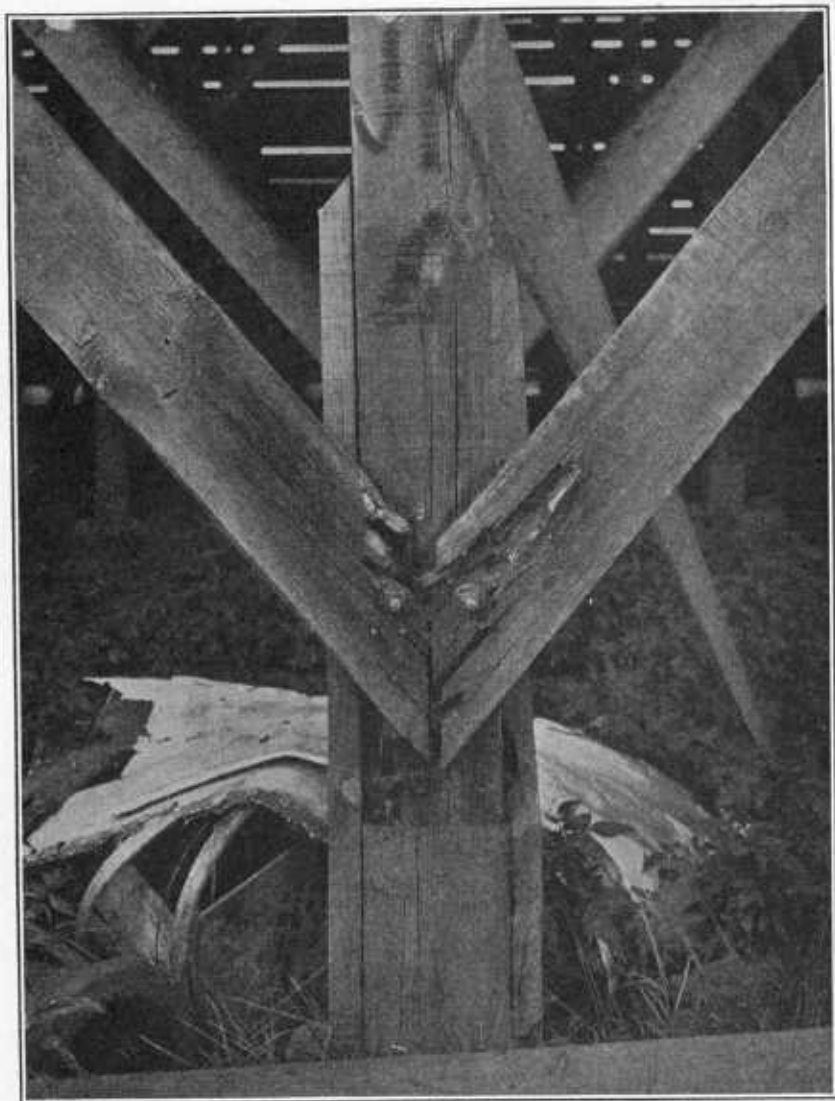


FIG. 6.—Decay in braces at a joint where moisture has collected.

weather. It may also be used for inside work wherever its color, odor, and other properties are not objectionable.

Coal-tar creosotes vary considerably in quality; but satisfactory results may be obtained from any good grade, provided a sufficient amount is put into the wood and a good penetration is secured. Creosotes containing a high percentage of oils which boil at a low

temperature are not so suitable for use on the farm as those which contain a lower percentage of these oils, because a considerable portion may evaporate and be lost during treatment. In some cases as much as one-fifth of the oil used has been lost in this way. This loss of oil by evaporation may be largely offset, however, by the lower price at which the low-boiling creosotes may usually be obtained. The increase in price which can be economically paid for the higher-boiling creosotes will in general not be more than from 25 to 35 per cent. Generally, when a considerable amount of creosote is to be used, it is purchased under specifications. If required, further information on this point can be obtained from the Forest Products Laboratory, Madison, Wis.

CARBOLINEUMS.

Carbolineums are proprietary preservatives similar in appearance and preservative qualities to coal-tar creosote, but usually higher in price. In service tests made by the Forest Service on brush-treated telephone poles they have given about the same increase in durability as coal-tar creosote.

WOOD-TAR CREOSOTES.

But little reliable data upon the effectiveness of wood-tar creosotes is available, and until satisfactory service tests are completed no definite recommendation can be made. It is likely, however, that good results will be obtained if the wood creosote is of a high grade.

WATER-GAS-TAR CREOSOTE.

Water-gas-tar creosote is an oil similar in many ways to coal-tar creosote, but its value as a fence-post preservative has not been fully established. It is possible that good results would be obtained from its use in open-tank work.

ZINC CHLORIDE.

Zinc chloride is a toxic preservative that gives good results when properly applied and used under the right conditions. It is sold in solid form or in a 50 per cent solution, and is injected into the wood in a solution of from 2 to 5 per cent in water. It is much cheaper than coal-tar creosote. On account of its solubility in water, however, it is washed out of wood in time by the rain or ground water, which is the chief objection to its use.

In general, zinc chloride is not considered as satisfactory for farm timbers as coal-tar creosote, but there may be cases where its use is advisable. For wood to be used indoors it may in some cases be satisfactory where creosote would be objectionable on account of its odor, color, etc. It is not recommended, however, for use by the brush method.

TAR.

Tar is not a good preservative for farm use; and, in general, good results have not been obtained with it when applied by methods that are practicable on the farm. Its chief defect is that it does not penetrate the wood readily. Coal-tar and water-gas tar are also much less poisonous to the organisms which cause decay than is coal-tar creosote.

CRUDE OIL.

Crude oil is not sufficiently poisonous for a wood preservative. If the wood can be thoroughly saturated with it, water may be kept out and decay prevented; but it is very difficult, if not impossible, to get enough oil into most woods by processes which are practicable on the farm. For treating by the brush method crude oil is entirely unsatisfactory.

PAINT, LINSEED OIL, WHITEWASH.

Good results can not, in general, be expected from paint, linseed oil, or whitewash when used on fence posts or other timbers in contact with the ground. They do not penetrate the wood deeply, and the only way they can prevent decay is by preventing the entrance of fungi or moisture into the wood. Furthermore, the wood is seldom painted on all sides; so it is usually possible for fungus to enter through an unpainted part. Whenever, the painted film cracks or peels off, decay can also enter. It is quite common to see wood decaying beneath a coat of paint. (See figs. 5 and 7). If the wood were saturated with linseed oil it might prevent decay by keeping out the water; but this would be difficult to accomplish as well as being too expensive.

CEMENT COATINGS.

Posts have sometimes been dipped in thin cement and allowed to dry, leaving a coat of cement over the surface of the wood. Such a coating will not keep out water and is easily cracked or broken off. Good results can not be expected from this treatment.

PREPARATION OF TIMBER FOR TREATMENT.

Only sound wood is fit for treatment. If decay has made a start, it is not always entirely stopped by the treatment, but may continue beneath the treated wood until the interior of the post is destroyed. The first thing to consider, then, is the selection and preparation of the timber.

PEELING.

All timber should be peeled and thoroughly seasoned before the preservative is applied. In peeling posts of pine, cedar, and other coniferous woods, care should be taken to remove the thin inner bark from the part of the post that is to be treated. Even small patches of this bark often prevent penetration by the preservative.

(See fig. 8.) When the bark drops off, a patch of untreated or poorly treated wood is exposed, and the opportunity is offered for decay to enter. The effectiveness of the treatment depends on maintaining an unbroken area of treated wood entirely around the post. In some of the hardwoods strips of bark do not retard penetration so seriously.

BEVELING TOPS.

Beveling the tops of posts to a sharp edge, so that snow and water can readily drain off, is held by some to increase the durability of the tops. Theoretically this is a good practice, but there seems to be little definite proof that it results in an appreciable increase in durability.

SEASONING.

In order to obtain the best absorption and penetration of preservative the posts must be seasoned. The water and sap must come out of the wood to make room for the preservative to go in. Furthermore, wood treated green is likely to check open after treatment, exposing untreated wood. Seasoned wood which has been wet by recent rains is not in good condition to treat.

The best place for rapid seasoning is an exposed location on high ground. On damp or low ground or near a stream seasoning will take place much more slowly, and the wood will never get quite so dry. If properly piled in a good location, posts will usually season sufficiently for treatment in from 60 to 90 days of good seasoning weather. In exceptional cases they have been known to season in a month.

It is sometimes difficult to determine from its appearance whether timber is sufficiently seasoned or not. By weighing a few representative posts at regular intervals it is possible to determine the degree of seasoning very closely. When an ordinary sized post properly piled for seasoning does not lose more than a pound or two in weight during a week of good seasoning weather it may be considered dry enough to treat.

CHECKING.

Some woods, such as oak and chestnut, check very badly when dried too rapidly. It is well, if possible, to cut and peel such timber in the fall or winter, so that by the time warm weather comes it will be partially seasoned. Woods like pines, firs, etc., are usually not affected so seriously as the oaks by rapid seasoning.

PILING.

The posts should be open piled, so that the air will circulate freely around each one. The bottom of the pile should be raised 6 inches or a foot from the ground. Figure 9 illustrates a good method of piling. Another method, but somewhat less desirable because one

end of each post is on the ground, is illustrated in figure 10. If the ground is dry, the posts can be seasoned where they are cut by laying them upon rocks or brush, or keeping them off the ground in any



FIG. 7.—Painted post decayed at the ground line.

other way. Posts should never be piled in close piles or allowed to lie on the ground; for under such conditions they will frequently start to decay before they are seasoned. (See figs. 11 and 12.)

METHODS OF APPLYING PRESERVATIVES.

There are a number of methods of applying preservatives to wood, and they differ considerably in cost and effectiveness.

PRESSURE PROCESSES.

Impregnation under pressure is the most satisfactory means of injecting preservatives into wood. The various pressure processes differ in details, but the general principle is the same in all cases. The wood is placed in steel cars and run into a long steel cylinder. This is closed and the preservative is pumped in. Pressure is then applied until the desired quantity of preservative has been

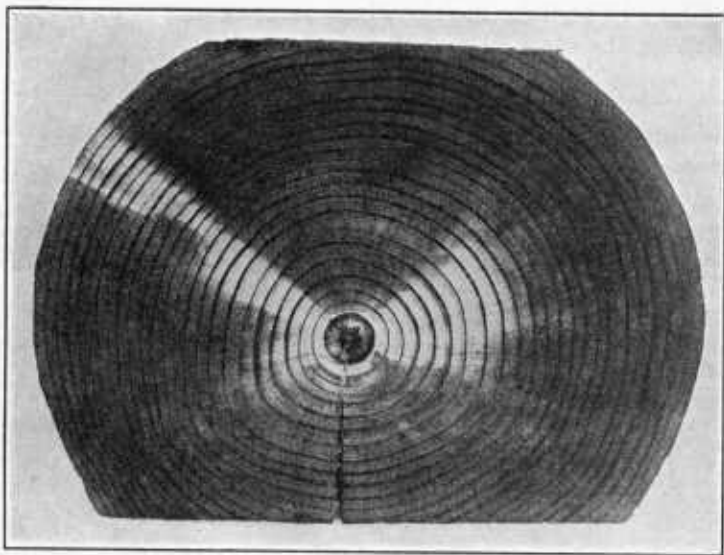


FIG. 8.—Treated pine tie. The light streak shows where penetration has been retarded by a strip of bark.

absorbed by the wood. There are over 90 plants in the United States using pressure processes, and millions of gallons of coal-tar creosote, zinc chloride solution, and mixtures of the two are used each year. It would be well for anyone living within reach of such a plant to consider having his timber treated there, if satisfactory arrangements can be made; for a good pressure treatment will usually be more effective than any treatment that can be made on the farm.

THE OPEN-TANK PROCESS.

The open-tank process is the most thorough method of treatment that is practicable on the farm. The posts are heated for one or more hours in the preservative (usually coal-tar creosote) at a temperature of from 180° to 220° F. They are then quickly transferred to a tank of oil having a temperature of about 100° F., and are left

there for one hour or more. In the hot bath the air and moisture in the wood expand and are partially driven out. When the wood is plunged into the cool oil the air and moisture in it contract and draw the oil into the wood. Except in the case of a few very easily treated woods, there is little absorption of oil by the wood during the hot bath. Instead of a separate tank being used for the cool bath, the heating of the oil in the hot bath may be stopped and the wood and the oil allowed to cool together. This accomplishes the same purpose as the cool bath; but a longer time is required because the hot oil cools very slowly. The single-tank treatment is particularly suitable for heavy posts or poles which can not be easily transferred from one tank to the other. It can sometimes be used to advantage also by heating for two or three hours early in the morning or in the evening and allowing the posts to cool all day or all night. This will make it

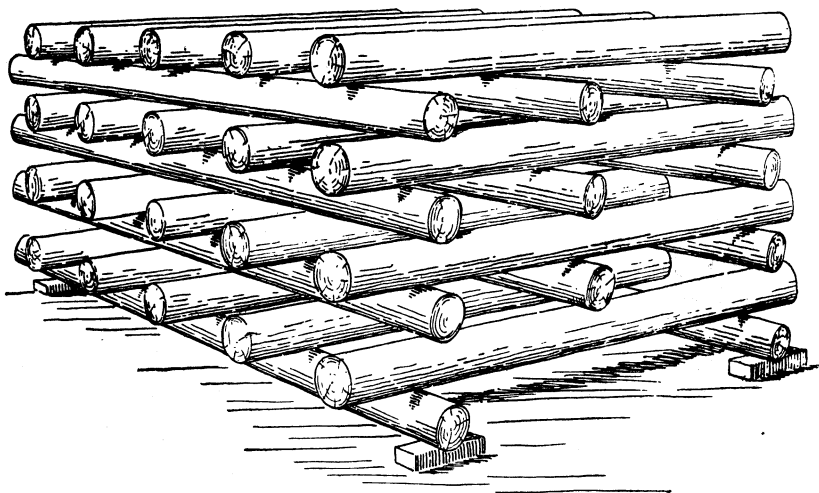


Fig. 9.—A good way to season posts.

possible to carry on the treatment without interference with the regular work of the farm. The posts may be treated more rapidly, however, by using the two tanks.

It is desirable in the open-tank treatment to have the sapwood penetrated all the way through by the oil. This is sometimes very difficult to accomplish, however, or requires too much oil, and a shallower penetration must then be accepted. A penetration of from one-half to three-fourths of an inch should give very good results. Even lighter penetrations, though they are not recommended, will probably give sufficient protection to pay for the cost of treating. The treatment should extend far enough up the post so that at least 6 inches of treated wood will be above the ground line when the post is set. During the cooling period the absorption of oil by the posts will lower the height of the oil in the tank. Care should, therefore,

be taken to see that there is always enough oil in the tank to submerge the posts to the proper depth.

The length of time the wood is held in the hot and cold baths should be determined by the penetration obtained and the amount of oil absorbed. The best treatment is the one that gives the greatest penetration with the least absorption of oil. The penetration may be determined by boring a small hole at the point where the ground line will be. This hole should be tightly plugged with a creosoted plug before the post is set. The reason for taking the penetration at the ground line is that this is the point at which decay is usually

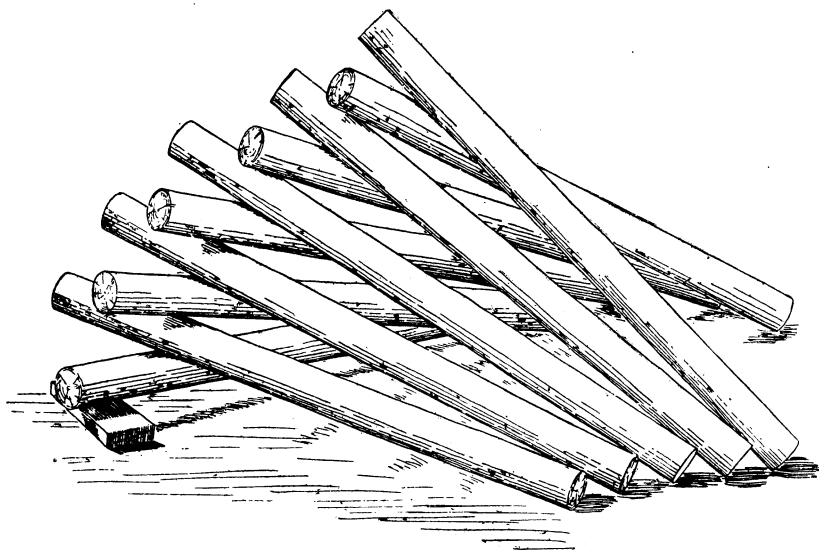


FIG. 10.—Another method of piling posts to season. Not so satisfactory as that shown in figure 9.

most severe, and, therefore, the point at which depth of treatment is most important.

Ordinarily it will not be necessary to leave the posts in the hot bath over 3 hours, and, in many cases, a much shorter time may give good results. The same is true of the cold bath. If the penetration of oil is not sufficient, either the hot or the cold bath should be lengthened. If the penetration is satisfactory, but too much oil is absorbed, the cold or cooling bath should be shortened. Green or partly seasoned posts or posts wet from recent rains require a much longer hot bath than seasoned dry ones. The amount of oil absorbed per post will vary with the kind of wood and the size of the post. In general, it should be between four and six tenths of a gallon for a post of from 5 to 6 inches in diameter.

During the heating period the temperature of the creosote should be kept as nearly constant as possible; or, still better, it should be allowed to increase very slowly. It should not be allowed to fluctuate

up and down, if this can be helped. Temperatures between 200° and 220° F. are satisfactory. For timber which treats very easily 180° may prove high enough. The temperature should not be allowed to go above 220° , as a certain amount of the oil is lost by evaporation at high temperatures. There is also danger that the

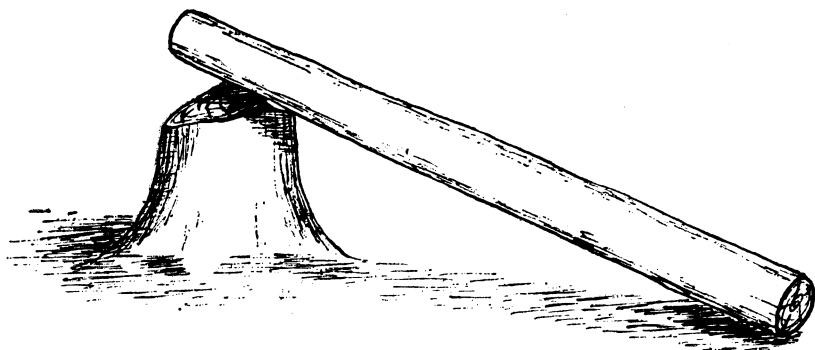


FIG. 11.—Seasoning against a stump.

oil will boil over the sides of the tank if the temperature gets too high. The “cold” bath should be warm enough to liquefy the oil thoroughly. A temperature of 100° F. will usually be found sufficient for this purpose.

Various woods differ so in their susceptibility to treatment that a general rule for treating can not be given. In Table 1, however,

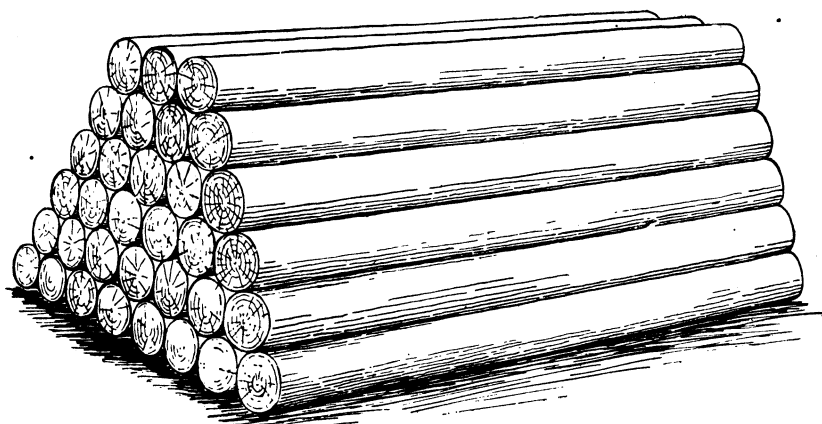


FIG. 12.—A close pile. A poor way to pile posts for seasoning.

are shown the results obtained in some experiments with a number of kinds of wood.

It will be noted that most of the posts in Table 1 were given a light top treatment in addition to the butt treatment. This is necessary only when the wood is of a species that is known to decay rapidly even above the ground line, or when the climate is warm and

moist, as that in some of the southern States. The tops, however, do not require as heavy treatment as the butts.

TABLE 1.—*Results secured in the treatment of various woods.*

[All posts were round, peeled, and seasoned.]

Species.	Absorption per 5-inch post.	Penetration.		Single-tank treatment.			Double-tank treatment.	
		2 feet from butt.	2 feet from top.	Butt.		Top.	Hot oil.	Cold oil.
				Hot oil.	Cooling oil.			
	<i>Galls.</i>	<i>In.</i>	<i>In.</i>	<i>Hrs.</i> 5	<i>Hrs.</i> 12		<i>H. min.</i>	<i>H. min.</i>
Ash, white.....	0.4	0.4				Dipped ^a		
Basswood.....	.6	.1	0.05				1	30
Beech.....	.6	1.0	.4				1	45
Birch, river.....	.6	.7	.3				3	1
Butternut.....	.4	b .5		6	12			
Elm, slippery.....	.6	b .3	.1				1 30	1 30
Elm, white.....	.4	b .4		6	12			
Gum, black.....	.6	.6	.3				1	1
Gum, cotton (tupelo).....	.6	.6	.3				1	1
Gum, sweet (red).....	.6	1.0	.3				1	45
Hickory, bitternut.....	.4	.5		6	12	Dipped ^a		
Magnolia, sweet (bay).....	.6	.4	.2				1	30
Maple, red.....	.6	1.0	.3				4	2
Maple, sugar.....	.6	.2	.1				3	2
Oak, pin.....	.5	b 1.0	.5	1			1	45
Oak, red.....	.4	b .5	.3				1	45
Pine, loblolly.....	.5	1.5	1.0				1 30	1
Pine, lodgepole.....	.6	1.2	.6				1 30	1
Pine, pitch.....	.5	1.0	.3				3	1
Pine, scrub.....	.5	1.0	.4				3	2
Pine, shortleaf.....	.5	1.0	.3				3	1
Pine, western yellow ^c5	.7					2 30	1 30
Poplar, white.....	.5	.5	.2				6	12
Sycamore.....	.6	1.0	.2				1	30
Tulip tree.....	.6	.4	.1				2	30
Willow, white ^d6	.6	.2				4	1

^a Dipped for 5 minutes or more.^b Width of sapwood. Penetration limited by impenetrable heart.^c Average results from 6,000 posts.^d Requires especially thorough seasoning.

There are two methods of giving the top treatment. In one method the cold tank is made long enough to hold the posts lying full length. In this case, when the posts are transferred to the cold tank, they are entirely submerged in the oil. This results in a comparatively heavy absorption in the butts, which have been heated, but only a light absorption in the tops. Another method is to complete the butt treatment of the posts first, and then turn them upside down in a tank of hot oil and allow them to remain for a few minutes. The oil should be deep enough in the tank to cover all the post not treated before. If this is not possible, a swab should be used to souse the oil all over the wood not submerged. The swab can be made by tying a piece of burlap on a stick. Particular pains should be taken to fill all checks and cracks with the oil.

Sometimes, in seasoning, the outer surface of the wood becomes hard and has a glazed appearance. This effect is called "case-

hardening," and it may seriously retard penetration by the oil. The remedy is to shave off the hardened surface with a draw-shave for from 6 to 8 inches above and below the ground line. The rest of the butt need not be shaved.

After treatment it is a good plan to stand the posts upside down. This allows any excess oil in the butts to flow toward the top and stay in the wood, instead of dripping on the ground. They should not be left in this position more than a few weeks, especially if the tops are untreated, as decay may start in the part which touches the ground.

APPARATUS FOR OPEN-TANK PROCESS.

Various forms of apparatus are used in open-tank treatments. The essential parts of the apparatus for general farm use are one or two tanks (depending on whether the hot and cold or hot and cooling method is used), a thermometer, and some means of heating.

The chief requirements of the tanks are: (1) that they shall be strong enough to hold the weight of the oil and the posts; (2) that they shall not leak; (3) that they shall be deep enough so that the top of the oil will be a foot or more below the top of the tank during treatment; and (4) that they may be readily heated. Any tank of convenient size which will satisfy these requirements will do. The heating may be accomplished by a fire beneath the tank, or by means of steam coils, if steam is available. If an open fire is used, care should be taken to prevent the oil from slopping over the side of the tank and taking fire. This is the reason for having the top of the oil a foot below the top of the tank. Though the oil is not dangerously inflammable, and ordinary care will prevent trouble, carelessness may result in the loss of the oil and the posts. The treatment should be made, of course, in a situation where an accidental fire will not endanger any buildings.

In figure 13 is shown a plant made from oil drums by cutting out one head of each drum. In order to keep the posts from floating in the oil, it is well in a plant of this kind to use a false bottom in each drum, such as is shown in the figure. This can readily be made out of the heads cut from the drums, or any flat piece of iron, by riveting on strips of iron through which several screws protrude from one-half to three-fourths of an inch. The screws stick into the posts and keep them from moving about and floating in the oil.

Figure 14 shows a more permanent type of plant, in which the tank is made of comparatively heavy metal and is surrounded by a brick fire box.

Figure 15 shows a plant built for treating the entire post, giving a heavy butt treatment and a light top treatment. The horizontal tank is 8 feet long, 3 feet wide, and 3 feet deep; the round tank, about 3 feet in diameter and 4 feet deep. The pole and stand shown are for

use in connection with the mortised board shown in the rear, to hold the posts under the oil during the cold bath.

In figure 16 the details of construction of the tanks used in one experimental plant are shown. This was a portable plant heated by steam, which was furnished by the boiler of a threshing engine. Between the steam pipes in the bottom of the tanks strips of 2-inch lumber studded with screws were placed and firmly wired to the pipes. The points of the screws projected about three-fourths of an inch above the wood and served to keep the posts from sliding about.

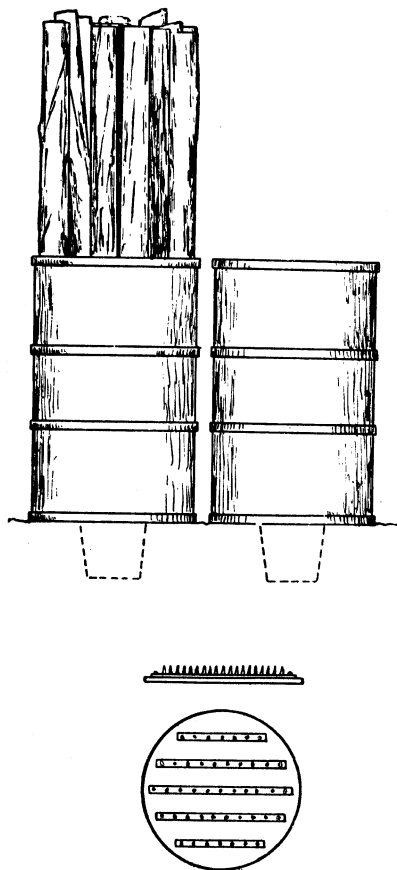


FIG. 13.—Treating plant made from two oil drums, showing method of constructing false bottom.

Without the screws it would have been impossible to put a full charge of posts into the tank. On both sides of each tank, about 18 inches from the top, 2 by 12 inch planks were suspended by means of U-shaped irons which hooked over the sides of the tanks. This made a very satisfactory working platform. The capacity of the tanks was from 40 to 105 posts per charge, depending on the size and shape of the posts.

The number of posts to be treated should determine the character of the plant used. If only a few posts are to be treated, a simple plant similar to that shown in figure 13 is most suitable. For a large number of posts or timbers of other kinds, more elaborate apparatus is advisable, such as that shown in figure 16, or perhaps a stationary plant with a complete equipment of a steam boiler, storage tanks, oil pumps, a derrick for lifting the timber, etc. In any kind of a plant



FIG. 14.—Heavy iron tank with brick fire box.

the ingenuity of the operator will be called upon to provide platforms and other means of handling the posts to the best advantage.

It may prove of advantage sometimes for a number of farmers to cooperate in the crection of a permanent plant of this kind or a portable plant, such as that shown in figure 16. Such a plant could either be loaned to each of the cooperators in turn to treat his own timber or it could be placed in charge of an operating crew of two or three men who would make all the treatments.

COLD-BATH OR SOAKING TREATMENT.

In the cold-bath process the wood is treated by soaking for long periods in a tank of preservative at ordinary air temperature. This method of treatment has not been thoroughly investigated, but it is probable that but few woods can be successfully impregnated in this way with oils, since cold oils do not penetrate wood readily. Water solutions like zinc chloride would probably penetrate somewhat more readily. In any case it would be necessary to have the wood particularly well seasoned.

THE DIPPING PROCESS.

The dipping process is considered suitable only for preservatives of an oily nature. The wood is simply heated in oil at from 200° to 220°

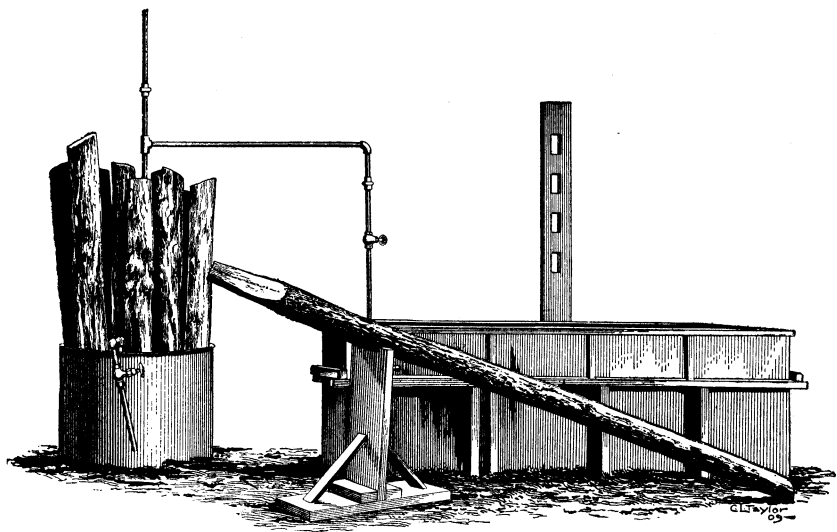


FIG. 15.—Experimental outfit heated by steam. The rectangular horizontal tank is for the cold bath.

F. for from 5 to 15 minutes, or longer. This allows all checks and defects to become filled with oil, but the penetration and absorption of oil are usually slight. On account of the small amount of oil used and the large number of posts that can be treated in a day, it is much cheaper than open-tank treatment, but it is also much less effective. Under no circumstances should any but thoroughly peeled, well-seasoned timber be used. Unseasoned wood, or that which is wet with snow or rain, is not suitable because the oil will not penetrate it readily. In very cold weather a longer time in the hot oil will be required to get the wood warm. The treatment should extend at least 6 inches above the ground line.

Dipping is more suitable for protecting the sapwood of comparatively durable posts than for nondurable posts. It may add from

1 to 3 or 4 years to the life of a durable post which ordinarily would last 8 or 10 years untreated. This is well worth the cost of the treatment. An addition of three or four years to the life of a nondurable

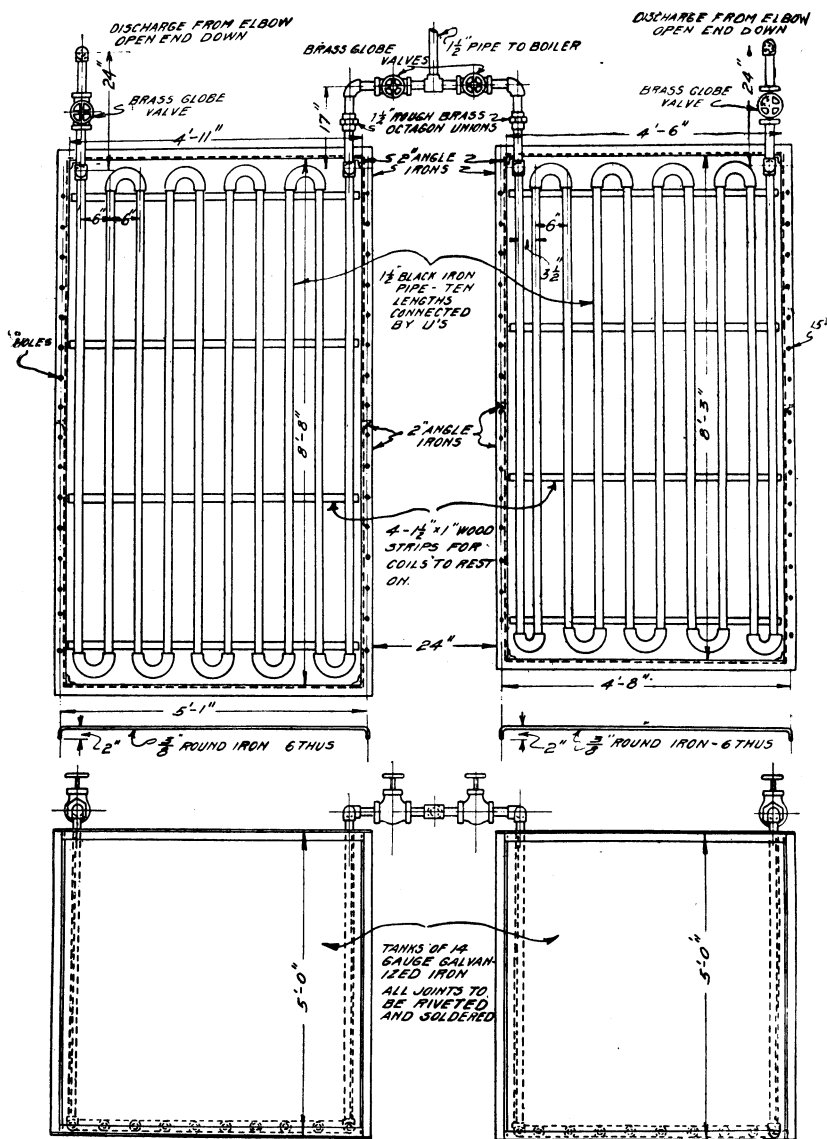


FIG. 16.—Details of construction of tanks for portable plant.

post which would last only two or three years untreated would increase the value of the post more than enough to pay for the treatment, but it would still have a comparatively short life. If possible, non-

durable species should be given a better treatment, such as the open-tank or pressure treatment.

The apparatus for dipping consists of a tank, a thermometer, and some means of heating. Generally, it will be advisable to use a comparatively small tank in order that there will not be a large amount of oil left over after the last posts have been treated.

BRUSH TREATMENT OR PAINTING.

Brush treatment or painting is also considered suitable for oils only and consists in applying two coats of hot preservative to the wood. The oil should be heated to from 200° to 220° F. and flooded over the wood rather than painted upon it. Especial care should be taken to fill every check and defect in the wood, and the first coat should be allowed to dry completely before the second coat is applied. The advantage of the painting method over the others is the small amount of preservative it requires and its cheapness and simplicity. No excess of preservative need be left over after the last post is treated. It is also of value in treating portions of large sticks which can not readily be dipped or open-tank treated, and in treating timber at joints and all points of contact where decay is liable to occur. Its disadvantage is that it usually adds less to the durability than dipping, open-tank, or pressure treatment.

Like dipping, the painting method is most suitable for use on peeled, thoroughly seasoned, and dry timber. It is best to use it in warm weather; for in cold weather, when the hot creosote touches the cold wood, it immediately cools and does not penetrate readily. Both treatments are more suitable for protecting the sapwood of durable posts than for very nondurable posts.

The apparatus for brush treatment consists of a large kettle or pail of some kind to heat the oil in, a smaller pail to paint from, and a wire-bound, long-handled paint brush. An old broom might be substituted for the paint brush if desired. If a thermometer is available, it can be used to advantage. If none can be had, the oil should be heated very hot but not to boiling. Care should be exercised to prevent the oil from boiling over and taking fire.

Ordinarily the oil is heated over an open fire; but in cases where a large amount of work is to be done, or the work is widely distributed, it may be found advantageous to use a special oil heater, such as is shown in figure 17. The heat is supplied by a gasoline blow torch, and a thermometer is used to regulate the temperature. The pail is made detachable, so that one or more can be in use while another is heating. The construction of the heater is simple, and it can be made by any competent tinner.

CARE OF TIMBER AFTER TREATMENT.

The effectiveness of any of the methods of treatment which have been described is dependent upon keeping an unbroken layer of treated wood over the entire treated surface.

Care should be exercised in handling treated timber to see that the treated wood is not scraped away and untreated wood exposed. If such an accident does occur the exposed untreated wood should be given two or three coats of hot creosote.

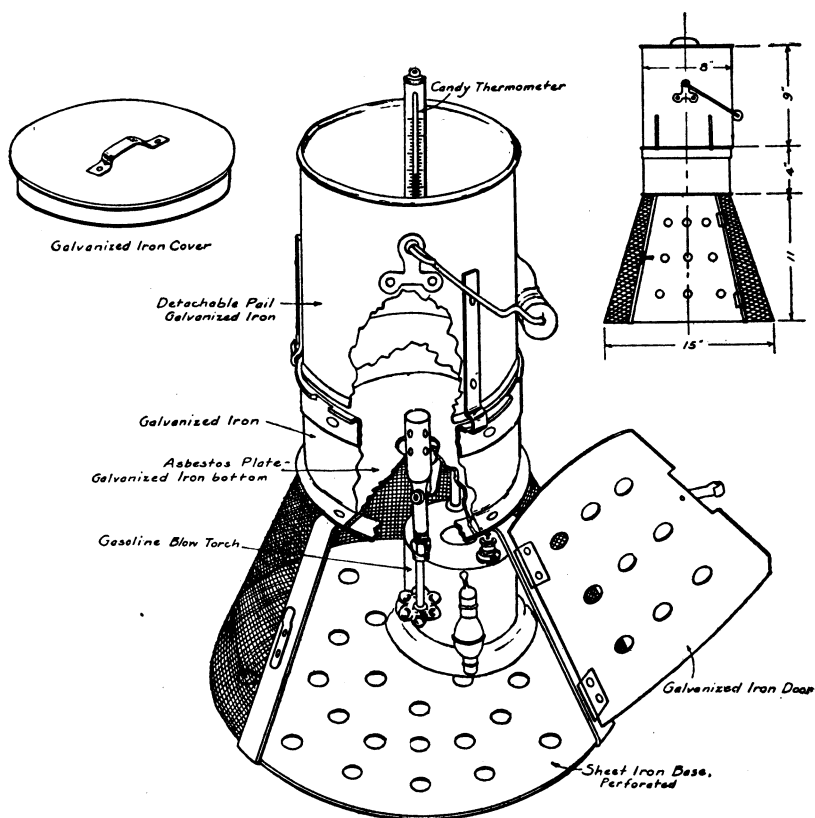


FIG. 17.—Creosote heater for brush treating.

Treated timber should never be cut if it can be avoided. All sawing and framing should be done, if possible, before treatment. If it is necessary to saw after treatment, the exposed untreated wood should be painted with creosote before it is put in place.

If butt-treated posts or other timbers of which only a part is treated are not to be used for some time, they should be open piled after treatment. If they are close piled or allowed to lie on the ground for a considerable length of time, decay is likely to start in the

untreated parts. If the timber is treated all over, it should be close piled, but the pile should be raised off the ground.

In setting treated posts, poles, etc., great care should be used to avoid setting them too deep. At least 6 inches of treated wood, and more if convenient, should extend above the ground after the posts are set. In a number of cases where this precaution has not been observed the posts have decayed above the treated part.

ADAPTABILITY TO TREATMENT.

As is shown in Table 1, some species of wood are much easier to treat than others; and whenever there is a choice between several species this fact should be taken into consideration.

In general, the pines are very easy to treat. Other woods which have been found to treat very readily in the form of round posts are beech, river birch, gum, pin oak, red oak, and sycamore. Many other species, however, can be successfully treated; and, in fact, almost any kind of nondurable wood can be improved by proper treatment. Treatment will also greatly improve many of the species having durable heartwood and nondurable sapwood.

In most woods the sapwood treats much more easily than the heartwood. In very few species can a satisfactory penetration be obtained in the heartwood by the open-tank process. In general, therefore, a more uniform and satisfactory treatment can be obtained in round posts, of which the entire outer surface is sapwood, than in split or sawed posts, in which heartwood is necessarily exposed. Among the exceptions to this rule are hemlock, in which the sapwood is as difficult to penetrate as the heartwood, and sycamore, in which the heartwood is readily treated.

In some localities there are considerable amounts of standing dead timber which has been killed by fire, insects, or some tree disease, and which is still sound. For the most part this timber can be successfully treated. Such timber, if it is entirely free from decay and not seriously injured by wood borers, is practically as good as live timber and is well adapted to treatment because already more or less seasoned. It makes good material for posts, poles, and many other of the common forms in which wood is used. Blight-killed chestnut and fire and insect killed lodgepole pine are in this class.

COST OF TREATMENT.

As a rule, the principal item of cost in the treatment of timber is the preservative. The price of creosote varies. Near the manufacturing plants it can usually be obtained at from 20 to 35 cents per gallon in small lots. In other localities the freight will make the price somewhat higher. In tank-car lots the price ranges from 10 to 25 cents per gallon. It may prove feasible in some cases for a

number of farmers to cooperate in buying creosote in order to obtain the reduction in price due to purchasing in larger quantities. The exact cost in any case will have to be determined by inquiring of the dealer from whom the oil is to be obtained.

The cost of applying the preservative depends mainly upon the number of posts to be treated, the cost of apparatus, labor, and fuel, and the number of posts which can be treated per day. The number of posts treated per day will, of course, vary according to their size and ease of treatment, the size of the plant, etc. Fuel and labor charges are sometimes ignored in fence-post treatment, and the number of posts treated per day is then not quite so important. The cost of treatment will vary greatly in different localities, and in accordance with differing local conditions, so that a general cost figure can not be given. In Table 2, however, are given some figures obtained in the open-tank treatment of posts in several localities. The cost of oil may now be somewhat greater than that given in the table. The cost of the apparatus is not included in the calculations.

TABLE 2.—*Cost of treatment under certain conditions.*

Locality.	Kind of post.	Cost of oil.		Cost of treating.	Total cost of treating.	Remarks.
		Per gallon.	Per post.			
Louisiana.....	Loblolly pine.....	\$0.15	\$0.09	\$0.01	\$0.10	Entire post impregnated, cost of labor not included.
Maryland.....	Scrub pine.....	.15	.09	.01	.10	Do.
Maine.....	Quaking aspen....	.12	.06	.01	.07	Butt impregnated, top dipped, cost of labor not included.
Minnesota.....	Cottonwood.....	.12	.06	.01	.07	Do.
California.....	Western yellow pine.	.24	.12	.07	.19	Butt impregnated; cost of labor included at \$2.50 per day.

VALUE OF TREATMENT.

Unless a reasonable saving can be effected by preservative treatment of wood, the expense involved is not justified. The saving due to preservative treatment will depend upon local conditions. In some localities durable posts are expensive and difficult to obtain; while nondurable, easily treated woods are abundant and cheap. It is in such localities that treatment is particularly desirable. In other localities there may be a plentiful supply of durable timber which can be obtained very cheaply. In such places it may not be advisable to attempt preservative treatment.

The chief points which must be considered in determining whether treatment will pay are the comparative cost and average life of untreated and treated posts. The cost and approximate life of untreated posts of the different species in common use in any locality will generally be known to the residents of that locality. It is esti-

mated that a thorough open-tank treatment of fence posts, for example, a heavy butt treatment and a light top treatment, will give even to nondurable woods an average life of at least 20 years. This estimate is based on the best information obtainable on the durability of creosoted posts and other creosoted timber. It can not be considered as conclusive, however.

In estimating the cost of an open-tank treated post the chief items to be considered are the original cost of the post and the cost of the oil absorbed. In general, from four-tenths to six-tenths of a gallon of creosote will be required per post. The cost of labor may or may not be included, according to the individual circumstances. In order to get a close estimate of the annual charge, the cost of setting the post and interest on the investment are sometimes included in the calculations.

If it is found in a certain locality that cedar posts which will last 12 years can be obtained for 30 cents and that treated pine which will last 20 years can be obtained for the same price, money will be saved by using the treated pine; or, if a locust post can be obtained for 35 cents and a treated beech post which will probably last about as long costs half as much, it will be economical to treat the beech. On the other hand, if an untreated post which will last 12 years can be obtained for 10 cents and a treated post which may be expected to last 20 years costs 30 cents, it will not be economy to treat.

SERVICE TESTS OF TREATED POSTS.

To obtain more exact information about the average life of treated posts under various conditions, experimental posts are being tested in fences in many parts of the country and careful records of their durability are being kept. In Table 3 are given the results so far obtained in a number of these experiments.

TABLE 3.—Results so far obtained in experiments on durability of creosoted posts.

Location.	Kind of posts.	Treatment.	Date set.	Date of last inspection.	Years' service at last inspection.	Number in test.	Number removed up to last inspection. ^a	Per cent removed up to last inspection. ^a	Remarks.
Ames, Iowa.	White cedar.	Open tank.	1909 and 1910.	June, 1915.	5 and 6	522	0	0	About one-third of these in bad condition, in tops, although not removed.
Do.	Black walnut.	do.	Spring 1909.	do.	6	50	0	0	
Do.	Willow.	do.	Fall, 1909.	do.	5½	45	0	0	
Zumbra Heights, Minn.	Basewood.	Entire post.	Winter, 1908.	June, 1913.	4½	481	3	0.6	Left in pile 2½ years; in ground 4 years.
Do.	Red oak.	do.	do.	do.	4½	254	1	0.4	
Do.	do.	Open tank, butts only.	do.	do.	4½	39	0	0	
Auburn, Ala.	Loblolly pine.	Open tank, entire post.	Summer, 1910.	Jan., 1915.	6½	55	0	0	Left in pile 2½ years; in ground 4 years.
Calhoun, La.	do.	do.	1908 to 1910.	do.	5 to 7	395	8	2	
Do.	Bay.	do.	1908 to 1910.	do.	5 to 7	145	27	19	
Do.	Cypress.	do.	do.	do.	5 to 7	70	1	2	Do.
Do.	Sweet gum.	do.	do.	do.	5 to 7	177	2	1.0	Do.
Do.	Tupelo gum.	do.	do.	do.	5 to 7	81	4	3.0	Do.
College Park, Md.	White oak.	do.	1909.	Nov., 1914.	5	51	0	0	1 missing.
Do.	Black gum.	do.	do.	do.	5	49	0	0	
Do.	Yellow poplar.	do.	do.	do.	5	51	0	0	
Do.	Scrib pine.	do.	do.	do.	5	101	0	0	3 missing.
Do.	Willow.	do.	do.	do.	5	103	0	0	
Do.	Maple.	do.	do.	do.	5	50	0	0	
Do.	Sycamore.	do.	do.	do.	5	52	0	0	3 missing.
Do.	Beech.	do.	do.	do.	5	51	0	0	
Do.	Chestnut.	do.	do.	do.	5	50	0	0	
Do.	Birch.	do.	do.	do.	5	50	0	0	3 missing.
Do.	Red juniper.	do.	do.	do.	5	45	0	0	
Clemson College, S. C.	Loblolly pine.	do.	Jan. to Aug., 1909.	Jan., 1915.	5½ to 6	279	37	13.2	
Do.	Yellow pine.	do.	do.	do.	5½ to 6	167	15	9.0	14
Do.	Post oak.	do.	do.	do.	5½ to 6	71	10	14	

^a A few posts show more or less decay, but since they were not removed at the time of the last inspection they are not recorded in these columns.

PROLONGING THE LIFE OF OTHER FORMS OF FARM TIMBERS.

There are many forms of timber used on the farm to which treatment can be advantageously applied. Among these are silos, rural telephone poles, shingles, greenhouse boards, sills, foundation timbers, bridge timbers, board walks, wooden gates, windmill frames, porch columns, well curbing, etc. The treatment of any nondurable wood which is used where conditions are favorable to decay is worthy of careful consideration.

SILOS.

A thorough treatment with coal-tar creosote will make a wooden silo more resistant to decay and less subject to shrinking and swelling. It will also make painting unnecessary.

The most satisfactory way to inject creosote into silo staves is by impregnation under pressure. It may sometimes be possible for a farmer to haul his untreated silo to a creosoting plant and have it treated, but pressure treatments will usually have to be made by the manufacturer before the silo is sold. Some manufacturers are already doing this, and it is now possible to purchase a pressure-treated silo all ready to set up.

Next to pressure treatment, open-tank treatment is best; but on account of the length of the staves and the long, narrow tank required it may be inconvenient to use this method. A good combination treatment would be to give the lower 2 or 3 feet of each stave an open-tank treatment and the remainder a two-coat brush treatment. If this is done, the part of the staves most subject to decay will receive the heaviest treatment. All the wood which touches the foundation should be thoroughly treated. As with any treated timber, no sawing or cutting that can be prevented should be done after the wood is treated. All untreated surfaces necessarily exposed by cutting should be heavily painted with the preservative.

Brush and dipping treatments are less efficient than open-tank or pressure treatments and will not give as great an increase in durability. They may be used to advantage, however, when the better methods are entirely out of the question.

One possible objection to the use of creosoted lumber in silos is that the silage might be contaminated by creosote bleeding from the wood. Information obtained by the Forest Service, however, indicates that there is little danger of this if proper care is used. In order to prevent contamination, the treated wood should be thoroughly air seasoned in open piles after it is treated and before it is put into the silo. In the case of open-tank or pressure treatments, the absorption of oil should not exceed 8 or 10 pounds per cubic foot.

Of the woods in general use for silo construction, the pines are, as a class, the most easily treated; hemlock, tamarack, spruce, and Douglas fir are somewhat more difficult. With pressure treatment the greatest saving can usually be effected by using the cheaper woods, as the difference in the durability of the various species is less after treatment than before. It is questionable if the treatment of such durable species as heart redwood and heart cypress would pay.

SHINGLES.

The application of paint is the preservative measure most commonly used for shingles; and, if the paint is properly applied, it will add to their durability by protecting them from the weather, keeping out moisture, and preventing cupping. If it is not properly applied, however, it may even hasten decay. From a preservative standpoint, the best way to apply the paint is by dipping the shingles in it. This may be found impracticable, however, since the amount of paint which would adhere to the shingles would in many cases be too great unless some means were provided to brush off the excess.

When the shingles are painted after the roof is laid, a ridge of paint is liable to form at the base of each shingle. This tends to hold the water after a rain and keep the shingles moist, thus making conditions more favorable to decay.

Brush treatment with creosote or a good shingle stain does not leave a ridge like ordinary paint and can be recommended as good practice, but dipping the shingles in the preservative is better in this case also. The best results in preventing decay are obtained, however, by first heating and then cooling the wood in the preservative, as described for the treatment of fence posts.

The open-tank process has already been explained. The apparatus used for posts may be employed; or if shingles exclusively are to be treated, the form of the outfit may be modified. The simplest apparatus is a single tank large enough to hold a bundle of shingles. If a larger capacity is desired, the depth rather than the width should be increased; for, in order to minimize the loss of oil by evaporation, the oil surface exposed to the air should be kept as small as possible. The best treatment for various kinds of shingles has not yet been determined. The most desirable treatment is the one which gives the best penetration with the least absorption of oil. Sap-pine shingles, thoroughly seasoned, can be completely penetrated without difficulty, but cedar shingles are more difficult to treat. The proper treatment in any case must be determined by observing the absorption of oil and the penetration secured and varying the treatment accordingly. The oil should not be allowed to get too hot, however, or the shingles held in it for too long a time; for in either of these events the shingles may become somewhat brittle.

While creosote treatment can be expected to increase very materially the resistance of shingles to decay, the treated shingles possess certain objectionable qualities which should be kept in mind when considering their use; for instance, their strong odor and their contamination of cistern water. Further, since the shingle nails become covered with creosote and can not be held in the workman's mouth, it is said to be more difficult to lay these shingles. The odor, however, disappears in the course of a few weeks—2 weeks in one case observed. The contamination of the cistern water may be of longer duration, though in one instance the water was tasteless after 3 days of rain. All these objections may be lessened if the shingles are seasoned for a few weeks between treating and laying.

It is held by some that creosote treatment makes shingles more inflammable and thus increases the fire danger, and it seems probable that this is true to a certain extent. It is a point, however, which has never been satisfactorily settled.

TELEPHONE POLES.

When farmers' cooperative telephone lines are constructed, the treatment of the poles will frequently effect a saving in the cost of upkeep. The open-tank treatment will, of course, give a much longer life than brush treatment; but the cost of the tanks, the extra oil required, apparatus for handling the poles, and the extra labor may not be justified unless a large number are to be treated. Brush treatment will, therefore, in many cases be the most practicable method to use. For the reasons given in the discussion of the dipping and brush treatment of posts, however, brush treatment of poles is most suitable for treating the sapwood of durable species. Poles of non-durable species should, if at all possible, be given a better treatment, such as open-tank, or even pressure treatment. In most parts of the United States a butt treatment is sufficient to protect the poles; but in the warm, moist climate of the southern States it is necessary to treat the entire pole, especially if sap pine or other nondurable woods are used.

The tops of the poles and the gains cut in the poles to hold the cross-arms should be brush treated. Pole braces should be treated like the poles. Wherever a pole brace touches a pole, both should be brush treated at the point of contact.

BRIDGE TIMBERS.

Treatment of the timbers and planks of permanent bridges will add materially to their resistance to decay. Open tank and pressure treatments are the best. Brush or dipping treatments of the face of the planks would soon be worn away and would be of little value; but they may be used to advantage in other parts of the structure.

SILLS AND FOUNDATION TIMBERS.

Sills and foundation timbers in contact with the ground or with stone or concrete foundations frequently decay rapidly, and preservative treatment is advisable. It is probable that brush treatment will usually be found the only convenient way to treat such timbers on account of their size, but wherever possible better treatments should be used.

LUMBER USED IN GREENHOUSES.

Lumber used in greenhouses is usually subject to rapid decay, which can be greatly retarded by preservative treatment. If creosoted boards are used close to steam pipes, however, some of the oil is volatilized by the heat, and the fumes have a bad effect on the plants. In other parts of the greenhouse, where the boards are not exposed to heat, the creosote has been found to have no bad effect on the plants. It is desirable in all cases to air season the boards thoroughly after treatment before putting them in service, in order to prevent the possibility of creosote bleeding from them after they are installed. Creosotes containing comparatively large amounts of low-boiling oils are not as suitable for greenhouse timbers as the oils of higher specific gravity, because they are much more volatile.

JOINTS AND POINTS OF CONTACT.

Experience has shown that in any timber structure where the wood comes in contact with wood, stone, or other material decay is liable to occur more rapidly at the point of contact than in other parts of the structure. If it is impracticable to treat the timber for the whole structure, it will frequently be profitable to give a good brush treatment to the joints and other points where decay is usually most severe.

CONCLUSION.

In every locality the question of preservative treatment of farm timbers should be given careful consideration. It is often difficult for a farmer to treat his own material efficiently. This, however, does not indicate that the work should be neglected, but only that some other means of securing the desired result should be sought. There are two practical methods of doing this. One is for some individual to undertake the work for the neighborhood. In many cases a small wood-preserving plant could be profitably operated in connection with a threshing outfit, a feed mill, or sawmill. The other plan is for several individuals to cooperate in establishing and operating a plant. The means may vary, but it can not be too strongly emphasized that every agricultural district should possess the facilities for increasing the durability of farm timbers by preservative treatment.